JET PROPULSION LABORATORY INTEROFFICE MEMORANDUM

June 10, 2005

TO: **David Morris**

FROM: **S. Guduru**

SUBJECT: **Assessment of Deep Space Network (DSN)'s ability to support Phoenix (PHX) EDL & Initial Surface operations and Kepler (KLM) launch during the period June through July 2008.**

As per an email request from Byron Yetter dated 04/28/05, RAPSO performed a loading study to determine the ability of Deep Space Network to support critical activities for both Kepler and Phoenix missions assuming 34-meter continuous coverage for both during the period June – July of 2008.

Background

PHX is scheduled to launch on 08/03/07. PHX Entry, Descent and Landing (EDL)/ Surface Operations Phase are dependent on the Launch Day. If PHX launches between 08/03/07 and 08/17/07 (first 15 days of launch window) it is scheduled to enter its Entry Descent and Landing (EDL) and Surface Operations Phase on 05/25/08. If PHX launches between 08/18/07 and 08/24/07 (last 7 days of launch window), EDL and Surface Operations Phase will begin on 06/05/08. But if PHX launches after 08/24/07, it is expected to reach Mars as late as 06/09/08.

KLM is scheduled to launch on 06/01/08. The initial acquisition, post launch support, system check out activities and Science Operations are scheduled from 06/01/08 through 07/31/08.

Assumptions

There is no planned 34M antenna downtime in 2008. All 34M DSN resources are available during the study period.

After landing at Mars, PHX will have no direct communication with Earth. Communication will be via UHF only and data will be relayed from Mars surface through Mars Odyssey (M01O) and/or Mars Reconnaissance Orbiter (MRO). This study is requested to assume continuous 34 meter coverage by M01O and MRO for this purpose. Since MRO is Prime on the 34-meter subnet, we assume continuous coverage by MRO for PHX in this study.

KLM launch occurs on the first day of the launch window (i.e. 06/01/08).

Mission Requirements

For EDL, PHX currently requires simultaneous coverage by all 34-meter Goldstone antennas for 4 hours, simultaneous coverage by all 34-meter Canberra antennas for 4 hours and a 6-hour Uplink support at DSS-63. For Surface Operations PHX requires 70M support but this study assumes 34M support and will be relaying through MRO which is expected to have continuous coverage during this period for this purpose.

KLM requires 34-meter continuous coverage during this period. On launch day it requires simultaneous coverage by all 34M Canberra (CAN) antennas (DSS-34, DSS-45) and DSS-46 for initial acquisition.

Analysis

Analysis was accomplished using the FASTER (forecasting and scheduling tool for earth-based resources) forecasting system and the updated mission set database from the February 2005 Resource Allocation review Board (RARB).

The DSN supportability for the two missions is evaluated under different Scenarios depending upon when the PHX EDL and KLM Launch occur to better understand the impact of each mission's requirements on the other mission.

Figure 1 shows a sample of the view period overlap between KLM and PHX during the study period. Kepler is represented by KLM and PHX relayed through MRO is represented by MAR6.

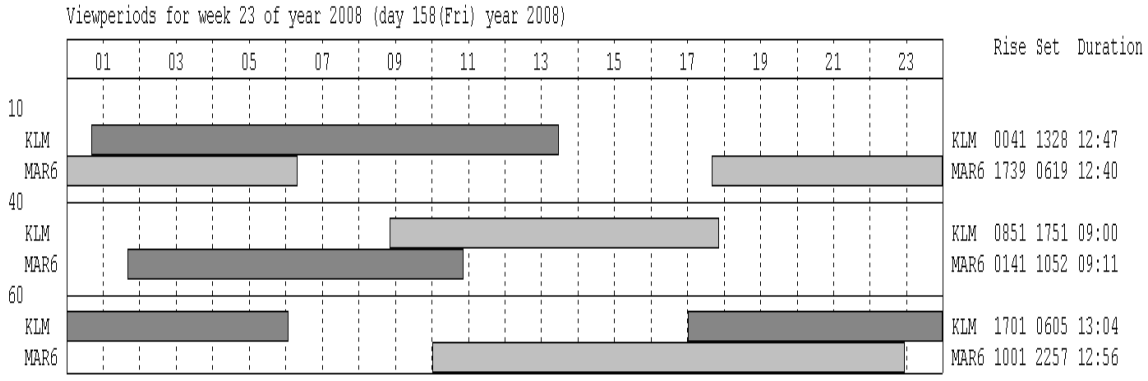

Figure 1

Kepler and Mars have significant view period overlap at Goldstone (GDS) and Madrid (MAD) and about 25% overlap at CAN.

Baseline Scenario: If KLM Launch occurs after PHX EDL (06/01/08)

On the day of KLM Launch, PHX will be in its Surface Operations phase and is requesting continuous coverage on 34M antennas for relaying through MRO.

Figure 2 shows the contention at GDS, CAN and MAD (as indicated in green) for KLM Launch. The contention is mainly at the view period overlap between CAN and MAD, MAD and GDS and between GDS and CAN. In order for KLM to have the required coverage for Launch, it must avoid scheduling on the same antennas as PHX on the Launch day.

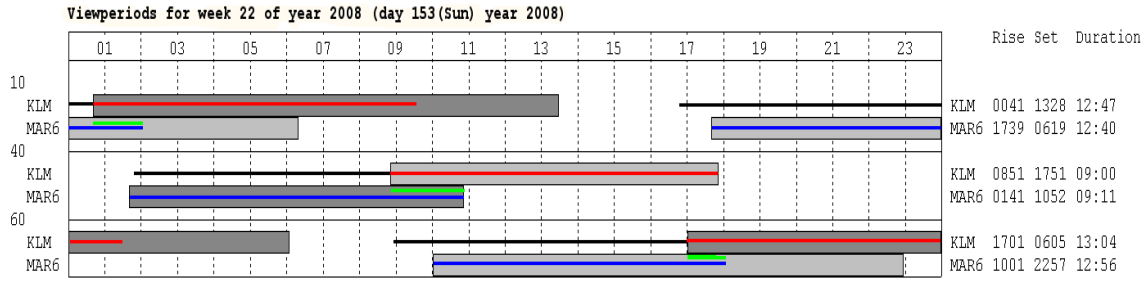

Figure 2

Scenario 1: If PHX EDL and KLM Launch occur on the same day (06/05/08 or 06/09/08).

In this scenario we are using the KLM launch view period and assuming that PHX EDL support will occur on the same day as KLM Launch.

Considering the view period overlap between the two missions, the extra setup time that is requested for EDL and Launch, and the fact that PHX will uplink for 6 hours at Madrid before EDL, followed by a 4 hour array support at GDS and a 4 hour array support at CAN, it is seen that PHX EDL and KLM launch will have significant contention at MAD and GDS (as indicated in green color in Figure 3 and Figure 4). KLM will know well in advance of their launch window (by August 2007) if there will be any interruption with PHX EDL and should avoid launching on the same day as PHX EDL.

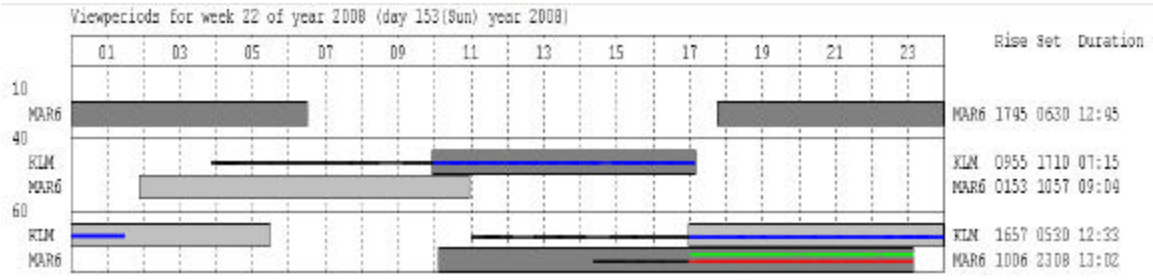

Figure 3

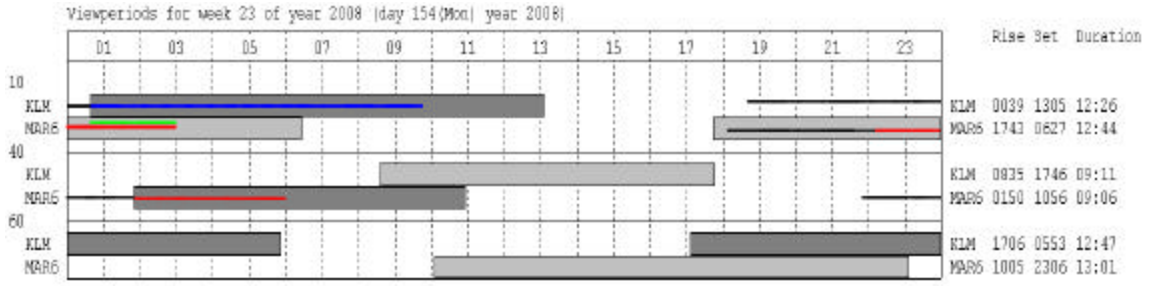

Figure 4

Scenario 2: If PHX EDL occurs on 6/5/08 or 6/9/08 after KLM launches.

There is no contention for PHX EDL at MAD, if PHX uses 70M for uplink support. KLM should use the following strategy to avoid contention with Mars at GDS and CAN.

- Schedule a 34-meter support to utilize maximum view at MAD.
- Transfer and schedule the support at GDS with minimum overlap between MAD and GDS.
- Schedule a support to utilize maximum view at GDS in order to avoid contention with Mars missions at GDS.
- Transfer and schedule the support at CAN with minimum overlap between GDS and CAN.
- Schedule a support to utilize the remaining maximum view at CAN in order to avoid contention with Mars missions at CAN.

Figure 4 outlines the strategy mentioned in Scenario 2.

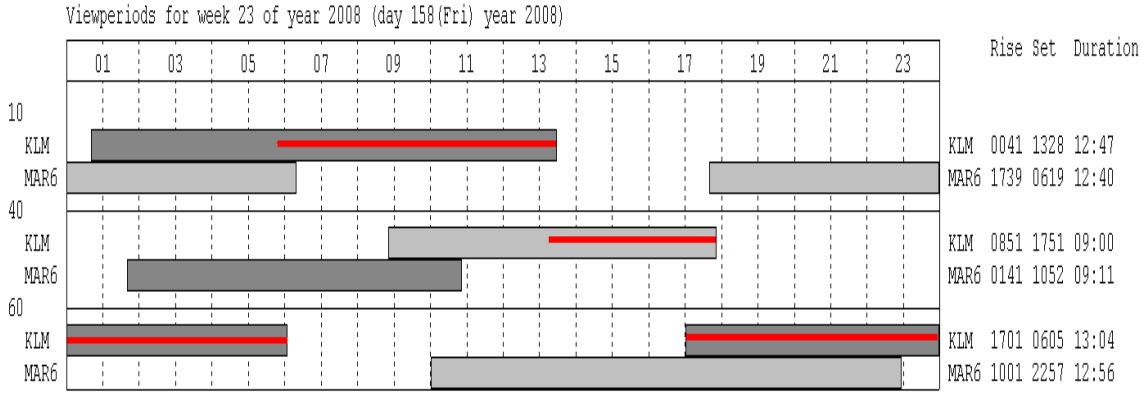

Figure 5

Scenario 3: PHX and KLM both require continuous 34-meter coverage post PHX EDL and KLM Launch.

KLM should follow the same strategy outlined in Scenario 2 to avoid contention at GDS and CAN. However at MAD, KLM has to begin its support at RISE to have an overlap with CAN support. Even if MRO begins its support at RISE at MAD, it should still have a 9-hour support at MAD in order to have an overlap with GDS for an hour. This extra hour support of MRO at MAD (indicated in green color on Figure 3) causes contention with KLM.

In order to avoid this contention, either they should be scheduled at different 34 meter antennas at Madrid or MRO support should be scheduled at 70M to relay back PHX data or PHX should relay through M01O scheduled at 70M during this period.

Figure 6 outlines the strategy that MRO should follow to avoid contention with KLM at GDS and CAN and to minimize contention at MAD.

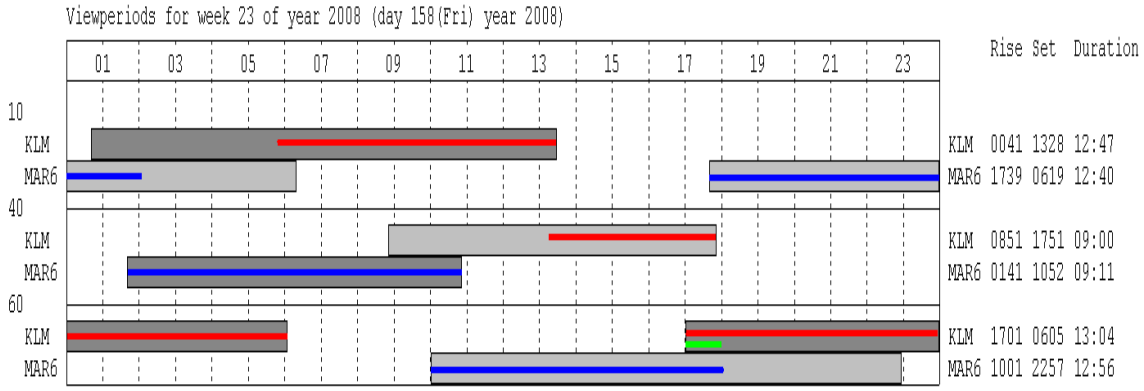

Figure 6

Contention with other Prime Missions during this period

Figure 7 shows the view period overlap of KLM with other prime missions during this period.

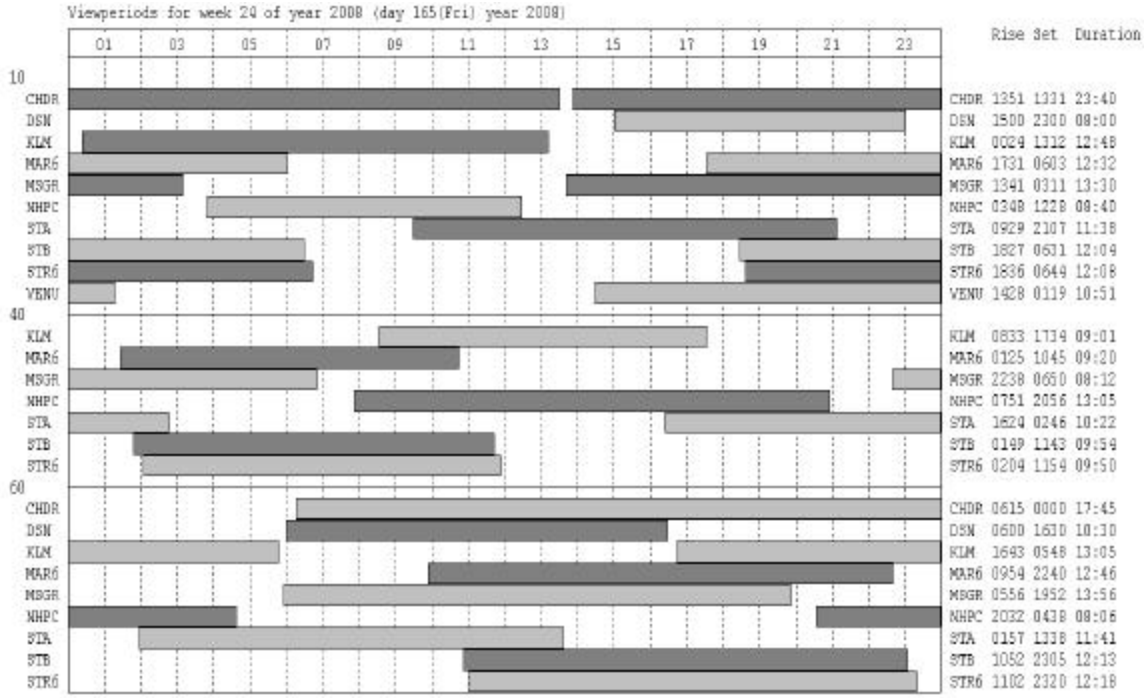

Figure 7

All the Mars Missions are requesting continuous coverage during this period. Mars Express (MEX) and Mars Global Surveyor (MGS) have already agreed to maximize MSPA among them and with M01O during this period according to previous RARB agreements. Since these missions are low in priority they have to reduce their support to accommodate KLM and PHX Relay.

Stereo-Ahead (STA) and Stereo-Behind (STB) require a 5-hour pass daily and can be scheduled outside of KLM view.

Rosetta (ROSE) is in hibernation mode and is not affected by KLM during this period.

New Horizons (NHPC) requires 2 hours of 34-meter support per week and can be scheduled outside of KLM view at CAN.

KLM in its early orbit is not affected by Sun view. Hence Messenger (MSGR) and DSN Maintenance are not affected by KLM.

All the affected Ground based activities have to accommodate KLM and PHX during this period.

KLM has significant overlap with Cassini (CAS). Following the strategy mentioned in Scenario 2, KLM can avoid contention with CAS at GDS and CAN. In order to reduce contention at MAD, KLM has to negotiate significantly with CAS or avoid scheduling on the same antennas as CAS.

Table 1 shows the current schedule for CAS at MAD during the study period in 2008.

Current Cassini schedule at Madrid during June-July of 2008	
Antenna	DOY
DSS-63	156,159,164,165,174, 181, 183, 184, 195, 198, 201, 204, 207,212
DSS-65	169, 177, 182, 213
DSS-54	172, 176, 179, 216
DSS-55	175, 178, 180, 196,

Table 1

On the other hand, CAS should follow the following strategy (as outlined in Figure 8) to minimize contention with KLM.

- Schedule a 34-meter support at RISE to utilize maximum view at GDS.
- Transfer the support to CAN at RISE with minimum overlap between CAN and GDS.
- Schedule a support to utilize maximum view at CAN in order to avoid contention with KLM at GDS.
- Transfer the support to MAD at RISE with minimum overlap between CAN and MAD.
- Schedule a support to utilize the minimum view at MAD in order to avoid view period overlap with KLM at MAD.

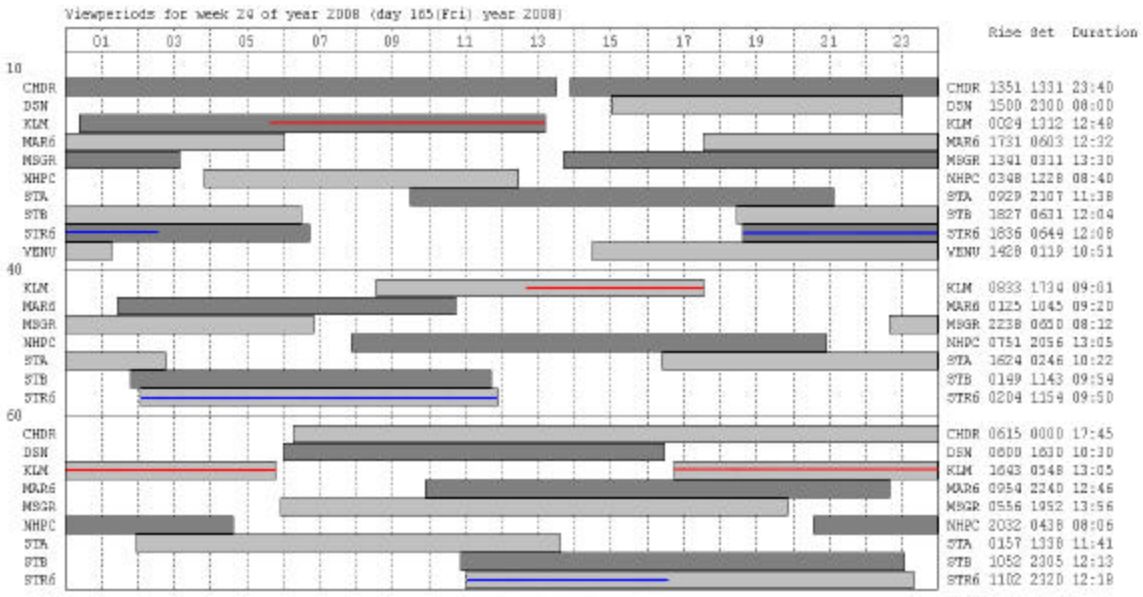

Figure 8

On the days when CAS needs continuous coverage, there will be contention at MAD with KLM (as indicated by green color in Figure 9) at the view period overlap between MAD and GDS for CAS.

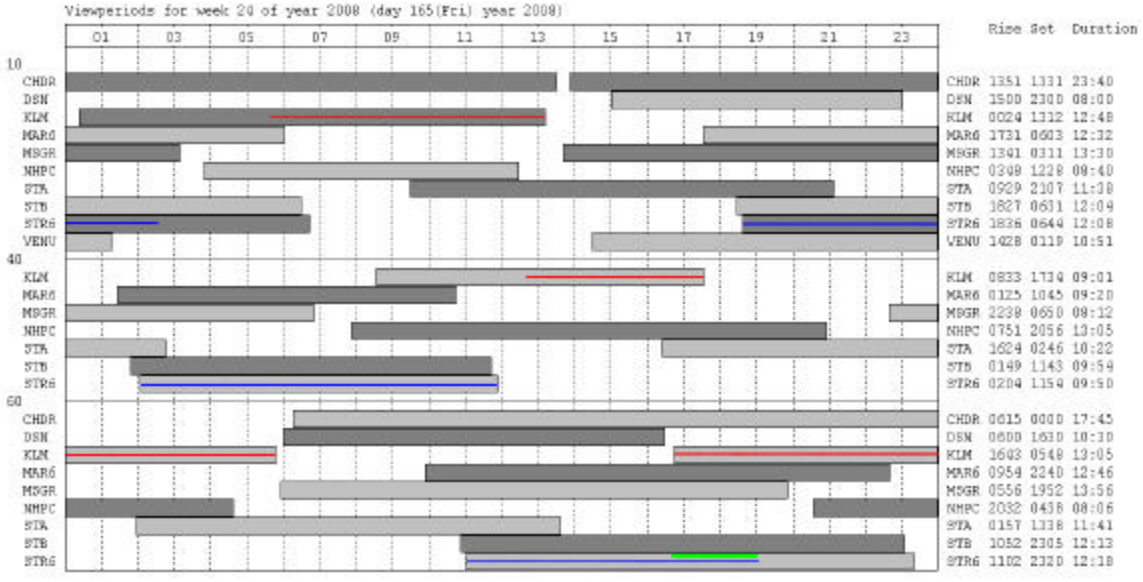

Figure 9

Conclusion

Kepler has significant overlap with Mars missions at Goldstone and Madrid. On the Launch day, it is recommended that KLM avoid scheduling on the same antennas as MRO (for PHX). If KLM Launch and PHX EDL occur on the same day (Scenario 1), increased contention is forecast. KLM will know well in advance of their launch window

(by August 2007) if there will be any contention with PHX EDL. It is suggested that KLM shift their launch window to avoid PHX EDL.

If PHX EDL were to occur after KLM Launch, contention at GDS and CAN could be avoided by following the strategy mentioned in Scenario 2. However to avoid contention at MAD, PHX should be scheduled at different 34 meter antennas respectively or at 70M.

When KLM and PHX are both requesting continuous coverage post EDL and Launch, there is contention at MAD which can be avoided as outlined above.

Analyzing the contention with other prime missions during this period it is seen that KLM has significant contention with CAS. Contention at GDS and CAN could be avoided by following the strategy mentioned in Scenario 2. KLM should avoid scheduling on the same antennas as CAS at MAD.

As always, the results of this study are preliminary in that network loading changes as requirements for planned missions are input and updated. We will continue to work with Kepler and other users of the DSN to maximize the time available for each individual user.